What is claimed is:

1. A dry-etching method which comprises dry-etching a metal thin film as a chromium-containing half-tone phase-shift film, wherein the method is characterized by using, as an etching gas, a mixed gas including (a) a reactive ion etching gas, which contains an oxygen-containing gas and a halogen-containing gas, and (b) a reducing gas added to the gas component (a), in the process for dry-etching the metal thin film.

2. The dry-etching method as set forth in claim 1 wherein said metal thin film is a chromium-containing half-tone phase-shift film consisting of a chromium film, a chromium oxide film, a chromium nitride film, chromium oxynitride film, chromium fluoride film or a laminated film thereof.

3. The dry-etching method as set forth in claim 1 wherein said reducing gas is a gas containing at least hydrogen.

4. The dry-etching method as set forth in claim 2 wherein said reducing gas is a gas containing at least hydrogen.

5. The dry-etching method as set forth in claim 1 wherein said reducing gas is hydrogen gas; a hydrocarbon gas selected from the group consisting of C_nH_{2n+2} (n=1 to 8), C_nH_{2n} (n=2 to 10), C_nH_{2n-2} (n=2 to 8); an alcoholic gas selected from the group consisting of CH_3OH, C_2H_5OH, $CH_3CH_2CH_2OH$, $(CH_3)_2CHOH$, $(CH_3)_3COH$, $CH_2=CHCH_2OH$; a hydrogen halide gas selected from the group consisting of HF, HCl, HBr and HI; ammonia gas; or water.

6. The dry-etching method as set forth in claim 2 wherein said reducing gas is hydrogen gas; a hydrocarbon gas selected from the group consisting of C_nH_{2n+2} (n=1 to 8), C_nH_{2n} (n=2 to 10), C_nH_{2n-2} (n=2 to 8); an alcoholic gas selected from the group consisting of CH_3OH, C_2H_5OH, $CH_3CH_2CH_2OH$, $(CH_3)_2CHOH$, $(CH_3)_3COH$, $CH_2=CHCH_2OH$; a hydrogen halide gas selected

from the group consisting of HF, HCl, HBr and HI; ammonia gas; or water.

7. The dry-etching method as set forth in claim 1 wherein said metal thin film is a chromium-containing half-tone phase-shift film consisting of a chromium film, a chromium oxide film, a chromium nitride film, chromium oxynitride film, chromium fluoride film or a laminated film thereof, said mixed gas comprises chlorine gas, oxygen gas and hydrogen gas and the relative flow rates of these gases are 66 to 46, 17 to 11 and 18 to 41 % by volume, respectively.

8. The dry-etching method as set forth in claim 2 wherein said metal thin film is a chromium-containing half-tone phase-shift film consisting of a chromium film, a chromium oxide film, a chromium nitride film, chromium oxynitride film, chromium fluoride film or a laminated film thereof, said mixed gas comprises chlorine gas, oxygen gas and hydrogen gas and the relative flow rates of these gases are 66 to 46, 17 to 11 and 18 to 41 % by volume, respectively.

9. The dry-etching method as set forth in claim 1 wherein said metal thin film is a chromium-containing half-tone phase-shift film consisting of a chromium film, a chromium oxide film, a chromium nitride film, chromium oxynitride film, chromium fluoride film or a laminated film thereof, said mixed gas comprises chlorine gas, oxygen gas and hydrogen chloride gas and the relative flow rates of these gases are 58 to 44, 15 to 11 and 28 to 45% by volume, respectively.

10. The dry-etching method as set forth in claim 1 wherein said metal thin film is a chromium-containing half-tone phase-shift film consisting of a chromium film, a chromium oxide film, a chromium nitride film, chromium oxynitride film, chromium fluoride film or a laminated film thereof, said mixed gas comprises chlorine gas, oxygen gas and hydrogen chloride gas and

the relative flow rates of these gases are 58 to 44, 15 to 11 and 28 to 45 % by volume, respectively.

11. A method for preparing a chromium-containing half-tone phase-shift photomask by performing a series of pattern-forming steps such as a step for forming a resist layer on a photomask blank, a step for exposing and patterning said resist layer, a developing step, a step for etching said photomask blank and a step for removing the resist layer, wherein the method is characterized in that patterns to be transferred onto a wafer are formed on said photomask blank for the chromium-containing half-tone phase-shift photomask according to the dry-etching method as set forth in claim 1 to thus give a photomask.

12. A method for preparing a chromium-containing half-tone phase-shift photomask by performing a series of pattern-forming steps such as a step for forming a resist layer on a photomask blank, a step for exposing and patterning said resist layer, a developing step, a step for etching said photomask blank and a step for removing the resist layer, wherein the method is characterized in that patterns to be transferred onto a wafer are formed on said photomask blank for the chromium-containing half-tone phase-shift photomask according to the dry-etching method as set forth in claim 2 to thus give a photomask.

13. A chromium-containing half-tone phase-shift photomask which is prepared by performing a series of pattern-forming steps such as a step for forming a resist layer on a photomask blank, a step for exposing and patterning said resist layer, a developing step, a step for etching said photomask blank and a step for removing said resist layer, wherein the photomask is characterized in that patterns to be transferred onto a wafer are formed on said photomask blank for the chromium-containing half-tone phase-shift photomask according to the dry-etching method as set forth in

claim 1.

14. A chromium-containing half-tone phase-shift photomask which is prepared by performing a series of pattern-forming steps such as a step for forming a resist layer on a photomask blank, a step for exposing and patterning said resist layer, a developing step, a step for etching said photomask blank and a step for removing said resist layer, wherein the photomask is characterized in that patterns to be transferred onto a wafer are formed on said photomask blank for the chromium-containing half-tone phase-shift photomask according to the dry-etching method as set forth in claim 2.

15. A method for manufacturing a semiconductor circuit which comprises the steps of transferring the patterns formed on the chromium-containing half-tone phase-shift photomask as set forth in claim 13 on a wafer on which a light-sensitive material is coated, developing said light-sensitive material to form resist patterns on the wafer, or to manufacture a semiconductor circuit which comprises coexisting coarse and dense patterns corresponding to said resist patterns.

16. A method for manufacturing a semiconductor circuit which comprises the steps of transferring the patterns formed on the chromium-containing half-tone phase-shift photomask as set forth in claim 14 on a wafer on which a light-sensitive material is coated, developing said light-sensitive material to form resist patterns on the wafer, or to manufacture a semiconductor circuit which comprises coexisting coarse and dense patterns corresponding to said resist patterns.

17. A semiconductor circuit having a circuit which comprises coexisting coarse and dense patterns corresponding to the resist patterns formed by transferring said resist patterns formed on the chromium-containing half-tone phase-shift photomask as set forth in claim 13 on a wafer on which a

light-sensitive material is coated and then developing said light-sensitive material.

18. A semiconductor circuit having a circuit which comprises coexisting coarse and dense patterns corresponding to the resist patterns formed by transferring said resist patterns formed on the chromium-containing half-tone phase-shift photomask as set forth in claim 14 on a wafer on which a light-sensitive material is coated and then developing said light-sensitive material.

19. A dry-etching apparatus used in dry-etching a metal thin film as a chromium-containing half-tone phase-shift film, wherein the apparatus is provided with a sequencer for establishing dry-etching conditions, wherein said metal thin film is a chromium-containing half-tone phase-shift film consisting of a chromium film, a chromium oxide film, a chromium nitride film, chromium oxynitride film, chromium fluoride film or a laminated film thereof; wherein if an etching gas used consists of chlorine, oxygen and hydrogen gases, the relative flow rates of these gases as expressed in terms of % by volume range from 66 to 46, 17 to 11 and 18 to 41% by volume, respectively, or if an etching gas used consists of chlorine, oxygen and hydrogen chloride gases, the relative flow rates of these gases as expressed in terms of % by volume range from 58 to 44, 15 to 11 and 28 to 45% by volume, respectively; and wherein the apparatus is so designed that when inputting the parameters relating to the foregoing dry-etching conditions, directly or through a memory device of a computer, to said sequencer and then starting the dry-etching process, the dry-etching is automatically carried out under the foregoing dry-etching conditions.

20. A dry-etching apparatus comprising an etching chamber, a transport chamber, a substrate cassette bed and a sequencer for establishing dry-etching conditions, wherein four electromagnets each comprising a square-

shaped ring-like coil are provided on an outer side of said etching chamber, two each of these electromagnets being opposite to one another and making a pair, these electromagnets being so designed that when applying a low frequency current which is 90 deg. out of phase thereto, the combined magnetic field established by these two paired electromagnets can rotate in a plane parallel to a substrate at a frequency identical to that of the low frequency current, an RF electrode and an opposite electrode are disposed in said etching chamber, a transport robot for transporting said substrate is provided in said transport chamber, said transport robot being a two-joint robot having two knots, the tip of a transport arm thereof being able to undergo advancing, reciprocating and rotating motions due to the composition of rotational motions of a motor axis and these two knots within each horizontal plane, the robot thus transporting the substrate, wherein a metal thin film to be dry-etched is a chromium-containing half-tone phase-shift film consisting of a chromium film, a chromium oxide film, a chromium nitride film, chromium oxynitride film, chromium fluoride film or a laminated film thereof, wherein if an etching gas used consists of chlorine, oxygen and hydrogen gases, the relative flow rates of these gases as expressed in terms of % by volume range from 66 to 46, 17 to 11 and 18 to 41% by volume, respectively, or if an etching gas used consists of chlorine, oxygen and hydrogen chloride gases, the relative flow rates of these gases as expressed in terms of % by volume range from 58 to 44, 15 to 11 and 28 to 45% by volume, respectively, and wherein the apparatus is so designed that when inputting the parameters relating to the foregoing dry-etching conditions, directly or through a memory device of a computer, to said sequencer and then starting the dry-etching process, the dry-etching is automatically carried out under the foregoing dry-etching conditions.